CLAIMS:

1. A method of producing a material comprising:

injecting precursor solution droplets into a thermal spray flame wherein a first portion of the precursor solution droplets are injected into a hot zone of the flame and a second portion of the precursor solution droplets are injected into a cool zone of the flame;

fragmenting the droplets of the first portion to form reduced size droplets and pyrolizing the reduced size droplets to form pyrolized particles in the hot zone;

at least partially melting the pyrolized particles in the hot zone;

depositing the at least partially melted pyrolized particles on a substrate;

fragmenting at least part of the second portion of precursor solution droplets to form smaller droplets and forming non-liquid material from the smaller droplets; and

depositing the non liquid material on the substrate.

2. The method of Claim 1, wherein the substrate is preheated to a temperature of about 150°C to about 600°C.

3. The method of Claim 1, wherein the substrate is maintained at a temperature of about 250° to about 700°C.

4. The method of Claim 1, wherein the precursor solution droplets have sufficient mass and velocity to carry the precursor solution droplets into the hot zone.

5. The method of Claim 1, wherein the substrate is selected from the group consisting of metals, coated metals, bond coated metals, ceramics, cermets, stainless steel, titanium, aluminum, nickel superalloys, ceramics, and plastics.

6. The method of Claim 1, wherein the precursor solution droplets comprise a precursor solution comprising a precursor salt selected from the group consisting of carboxylate salts, acetate salts, nitrate salts, chloride salts, alkoxide salts, and butoxide salts of alkali metals, alkaline earth metals, transition metals, and rare earth metals, and combinations comprising one or more of the foregoing salts.

7. The method of Claim 6, wherein the precursor salt is selected from the group consisting of zirconium nitrate, zirconium carbonate, zirconium acetate, yttrium nitrate, aluminum nitrate, gadolinium acetate, gadolinium nitrate, samarium acetate, samarium nitrate, ytterbium acetate, ytterbium nitrate, nickel nitrate, cerium acetate, lanthanum acetate, iron nitrate, zinc nitrate, and combinations comprising one or more of the foregoing salts.

8. The method of Claim 1, wherein the precursor solution droplets are injected radially at about 90° relative to the flame axis.

9. The method of Claim 1, wherein the precursor solution droplets are injected axially.

10. The method of Claim 1, wherein the precursor solution droplets have a diameter of about 0.5 to about 50 micrometers.

11. The method of Claim 1, wherein the thermal spray flame is a plasma spray flame.

12. The method of Claim 1, wherein the precursor solution droplets comprise multiple precursor solutions.

13. The method of Claim 12, wherein the multiple precursor solutions comprise different precursor salts.

14. The method of Claim 1, wherein the precursor solution droplets are injected using an atomizing injector nozzle.

15. The method of Claim 1, wherein the precursor solution droplets are injected using a piezo electric crystal induced liquid injector.

16. A material comprising splats having an average diameter of less than or equal to about 2 micrometers.

17. The material of Claim 16 wherein the splats have a thickness less than or equal to about 800 nanometers.

18. The material of Claim 16, wherein all splats are less than 5 micrometers in diameter.

19. The material of Claim 16, wherein the material has a porosity of about 1 to about 50 volume percent, based on the total volume of the material.

20. The material of Claim 19 wherein the porosity results from pores that are micrometer sized, submicron sized, nanometer sized or a combination of two or more of the foregoing.

21. The material of Claim 19 wherein the porosity is greater than or equal to about 8 volume percent and the porosity is three dimensional.

22. The material of Claim 16 wherein the material comprises at least one inter pass boundary.

23. The material of Claim 22 wherein the inter pass boundary has a thickness of about 0.1 to about 2 micrometers.

24. The material of Claim 22 wherein the inter pass boundary has a porosity of about 20 to about 95 volume percent, based on the total volume of the inter pass boundary.

25. The material of Claim 22 wherein there are no inter pass boundaries within about 50 micrometers of the substrate/coating interface.

26. The material of Claim 16 wherein the material comprises one or more vertical cracks.

27. The material of Claim 26 wherein the vertical cracks have lengths of about 0.5 to about 1.0 times the thickness of the material.

28. The material of Claim 26 wherein the vertical cracks are spaced at a distance up to two times the thickness of the material.

29. The material of Claim 26, wherein the material has a porosity of about 1 to about 50 volume percent, based on the total volume of the material.

30. The material of Claim 16, wherein the material has a thickness of about 1 micrometers to about 5 millimeters.

31. A wear resistant coating, corrosion resistance coating, thermal barrier coating, dielectric coating, catalytic film, electrolyte layer, electrode layer, thick metal oxide coating, solid conductive layer, soft magnetic film, semi-conductor film, sensor or activator comprising the material of Claim 16.

32. A structural preform, layered material, graded material or composite material comprising the material of Claim 16.

33. The material of Claim 16, wherein the material comprises a metal oxide, metal carbide, metal nitride, metal silicide or a combination of one or more of the foregoing.

34. The material of Claim 33, wherein the metal comprises aluminum, boron, sodium, potassium, lithium, calcium, barium, and magnesium chromium, iron, nickel, zinc, niobium, titanium, zirconium, scandium, yttrium, lanthanum, cerium, gadolinium, praseodymium, neodymium, samarium, terbium, ytterbium or a combinations comprising one or more of the foregoing metals.

35. The material of Claim 16, wherein the material comprises a stabilized or partially stabilized ceramic.

36. The material of Claim 35, wherein the stabilized ceramic comprises zirconia stabilized with yttria, zirconia stabilized with ceria, zirconia stabilized with scandia, zirconia stabilized with calcia, zirconia stabilized with magnesia, zirconia stabilized with gadolinia, zirconia stabilized with lanthia, zirconia stabilized with samaria, zirconia stabilized with neodymium or zirconia stabilized with ytterbia.

37. A thermal barrier coating comprising

splats having an average diameter of less than or equal to about 2 micrometers;

a thickness of greater than about 125 micrometers;

vertical cracks;

and porosity of about 15 to about 40 volume%, based on the total volume of the material.

38. The thermal barrier coating of Claim 37 comprising ZrO_2 and 7 percent by weight Y_2O_3 based on the total weight of the material.

39. The thermal barrier coating of Claim 37 further comprising at least one inter pass boundary.

40. The material of Claim 39 wherein the inter pass boundary has a thickness of about 0.1 to about 2 micrometers.

41. The material of Claim 39 wherein the inter pass boundary has a porosity of about 20 to about 95 volume percent, based on the total volume of the inter pass boundary.

42. The material of Claim 39 wherein there are no inter pass boundaries within about 50 micrometers of the substrate/coating interface.

43. The material of Claim 37 wherein the splats have a thickness less than or equal to about 800 nanometers.

44. The material of Claim 37, wherein all splats are less than 5 micrometers in diameter.

45. The material of Claim 37 wherein the porosity results from pores that are micrometer sized, submicron sized, nanometer sized or a combination of two or more of the foregoing.

46. The material of Claim 37 wherein the porosity is three dimensional.

47. The material of Claim 37 wherein the vertical cracks have lengths of about 0.5 to about 1.0 times the thickness of the material.

48. The material of Claim 37 wherein the vertical cracks are spaced at a distance up to two times the thickness of the material.

49. The material of Claim 37, wherein the material comprises a metal oxide, metal carbide, metal nitride, metal silicide or a combination of one or more of the foregoing.

50. The material of Claim 49, wherein the metal comprises aluminum, boron, sodium, potassium, lithium, calcium, barium, and magnesium chromium, iron, nickel, zinc, niobium, titanium, zirconium, scandium, yttrium, lanthanum, cerium, gadolinium, praseodymium, neodymium, samarium, terbium, ytterbium or a combinations comprising one or more of the foregoing metals.

51. The material of Claim 49, wherein the material comprises a stabilized or partially stabilized ceramic.

52. The material of Claim 51, wherein the stabilized ceramic comprises zirconia stabilized with yttria, zirconia stabilized with ceria, zirconia stabilized with scandia, zirconia stabilized with calcia, zirconia stabilized with magnesia, zirconia stabilized with gadolinia, zirconia stabilized with lanthia, zirconia stabilized with samaria, zirconia stabilized with neodymium or zirconia stabilized with ytterbia.

40. An electrolyte layer comprising

splats having an average diameter of less than or equal to about 2 micrometers;

a thickness less than about 200 micrometers; and

porosity less than about 5 volume% based on the total volume of the material.

41. The electrolyte layer of Claim 41 comprising ZrO_2 and 20 percent by weight Y_2O_3 based on the total weight of the material.

42. A thick metal oxide coating comprising

splats having an average diameter of less than or equal to about 2 micrometers;

a thickness of about 500 to about 5000 micrometers; and

a porosity of about 15 to about 40 volume% based on the total volume of the material.

43. The thick metal oxide layer of Claim 43 comprising Al_2O_3.

44. An anode layer comprising

splats having an average diameter of less than or equal to about 2 micrometers;

a thickness of about 20 to about 200 micrometers; and

a porosity of about 15 to about 50 volume% based on the total volume of the material.

45. The anode layer of Claim 45 comprising NiO or La_2O_3-doped CeO_2.

46. A coating comprising splats having an average diameter of less than or equal to about 2 micrometers wherein greater than or equal to about 90% of the splats are splats having an average diameter of less than or equal to about 2 micrometers and the porosity is less than or equal to about 10 volume percent based on the total volume of the coating.

47. The coating of Claim 46 wherein the coating has a thickness of about 1 micrometer to about 5 millimeters and there are no vertical cracks or inter pass boundaries.

48. A bulk structural material comprising splats having an average diameter of less than or equal to about 2 micrometers wherein about 80 to about 95% of the splats are splats having an average diameter of less than or equal to about 2 micrometers.

49. The bulk structural material of Claim 48 wherein the material has a thickness of about 5 millimeters to about 10 centimeters and no vertical cracks or inter pass boundaries.

50. A coating or bulk structural material comprising at least two alternating layers wherein one layer is a material comprising splats having an average diameter of less than or equal to about 2 micrometers and no vertical cracks or inter pass boundaries wherein about 80 to about 95% of the splats are splats having an average diameter of less than or equal to about 2 micrometers and another layer is a material having inter pass boundaries and optionally vertical cracks.